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TRANSLATION

BK-1425 ERECTING TOWER CRANE WITH A SEVENTY-FIVE TON LIFTING POWER

By

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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

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BK-1425 Erecting Tower Crane with a Seventy-Five Ton Lifting Power

By

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The development and perfection of production technology of construction-assembly operations requires the equipment of construction-assembly organizations with more powerful and improved mechanisms.

Before 1945 in the USSR (and abroad until recently) guy-derrick and rigid-base cranes, widely used in the assembly of blast furnaces, thermal and hydroelectric plants and other fabrications, were the basic assembly mechanisms with a lifting power higher than 5 to 10 tons. Such cranes are distinguished by small maneuverability, and their application is connected with the necessity of installing guys and anchors. In the last decade guy cranes in the USSR were almost completely supplanted by tower cranes with a 25 to 40 ton lifting power.

In 1952--1957 new, improved, models of heavy tower cranes were built of the type BK-151, BK-300, BK-404, BK-405, BK-406 and BK-406M. BK-300, BK-406 and BK-406M cranes equipped with tubular trihedral booms 30--40 meters long, which enlarged the area of the zone of attention from one crane stand 30%, and enlarged the lifting power on the maximum boom 20% (upon lowering the maximum lifting power from 40 to 25 tons and maintaining the calculated load moment). Such a change is justified

by the necessity of transporting the base stand of a crane during assembly of blast furnace constructions beyond the limits of the base installations (to 25 meters from the center of the furnace), which insures simultaneous accomplishment of all building and assembly operations on the central unit of the furnace.

The volume of blast furnaces under construction recently rose from 1,033 to 1,719 m^3; at the present time the planning is being terminated on a blast furnace with a 2,000 m^3 volume and a project is being prepared for a furnace 2,700 m^3. The power of electrical heating plants is also increasing significantly. In the construction of these objects assembly reinforced concrete is being more widely applied and all assembly elements are being enlarged 2 to 2.5 times. The weight of assembly parts and the necessity of further shortening the the periods of construction required an increase in the lifting power of erection mechanisms, a broadening of the radius of their action, and also a high mobility and speed of transportation.

In connection with these things, in 1957 the development of a planning task of a powerful erecting turret crane satisfying the requirements mentioned above was started.

In familiarization with the plans of the new powerful blast furnaces it was established that the maximum lifting power of such a crane should be 50--60 tons with a load moment of 1100 tm, i.e., almost 2 times greater than the BK-405 and BK-406 turret cranes.

It was acknowledged necessary to establish the lifting power of the new crane as 75 tons for the possibility of erecting enlarged units of technological and construction designs of powerful thermo-electric power plants.

In the development of the task the lifting power of the crane was set at 75 tons for the boom of 19 meters and 25 tons for a 45 meter boom. The load moment was determined as 1425 tm.

Planning of the cren was terminated in 1958. The first sample of the new crane

brand BK-1425, manufactured by the Ramenskiy and Orskiy plants of the Ministry of Construction of the RSFSR, was successfully tested in March 1959 and effectively used in the building of the blast furnace of the Nizhne-Tagil'skiy Metallurgical Company.

The BK-1425 cran (fig. 1) has the following technical characteristics:

Lifting speeds of the base hook (average) in m/min:

pully block consisting of 10 arms at maximum load 75 t..... I 0.8
II 3.6
III 6.4

pully block consisting of four arms at maximum load 30 t .. I 2.0
II 9.0
III 16.0

Lifting speeds of auxillary hook (average) at fixed load 5 t in m/min.. I 9.0
II 32.0
III 55.0

Turning speed in turns per minute 0.19

Speed of crane movement in m/min 12.2

Lifting winch of base hook:

tractive force in kg .... 2 X 9000
power of electric engines in kw .... 2 X 45

Lifting winch of crane arm:

tractive force in kg 9000
power of electric engines in kw 45

Turning winch:

tractive force in kg 18000
power of electric engine in kw 7.5

Lifting winch of auxillary hook:

tractive force in kg 5000
power of electric engines in kw .... 16 ≠ 22

Power of electric engines of transportation mechanism in kw ... 4 X 5

Total specified power of electric engines in kw................ 200

Overall weight of crane in tons 393

Including:

metal construction 218
mechanical electrical equipment 121
counterweight 54

Maximum load on one trolley in tons:

in operation of the crane 288
in transportation with a load of 30 tons 208

According to the size of the maximum load moment the BK-1425 crane has a power 2.5 greater than the heaviest of the existing types of cranes.

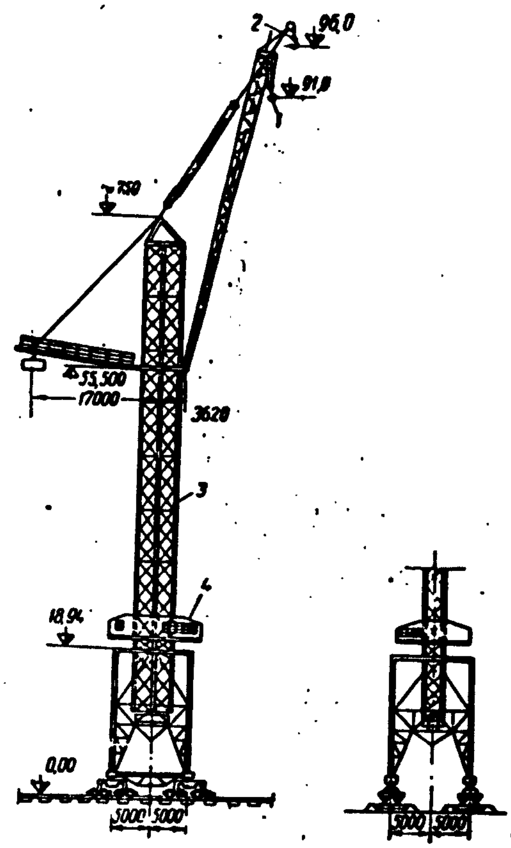

Fig. 1. Diagram of BK-1425 Crane. 1--Main hook; 2--Auxiliary hook; 3--Revolving turret; 4--machine section.

The BK-1425 crane may have two executions: in the first execution, indicated

in fig. 1, the main hook has a maximum boom of 45 meters, and the auxillary hook, 50 meters; in the second execution the main hook only has a maximum boom of 50 meters.

The crane arm has a trihedral cross section and parts made from pipes. A deck is constructed inside the arm for passage to the platform at the head of the arm, which is necessary for operations in modifying the number of working cables of the pulley block.

The design of the tower of the crane differs essentially from standard determinations. Usually in tower cranes the arm and counterweight are fastened to a rotary head which is fixed on top of the immobile tower. With this, the tower has a square cross section with dimensions specified in a railroad clearance which divides it into space sections.

To adopt such a cross section of the tower in the BK-1425 crane proved to be impossible because of the large buckling acting on the tower. Therefore, a rotary tower is applied here, to which the arm and counterweight are directly attached, in connection with the fact that the dimensions of the cross section of the tower are increased only in one direction, in the plane of action of buckling. Articulation of the tower is retained on space clearance sections (fig. 2); they are 2,800 x 2,800 mm and, being joined between one another in junctions, form a tower 2,800 x 5,620 mm.

The tower rests on a gantry by means of a pivot and horizontal rollers (fig. 3). Above the top of the gantry the frame of the machine section is fastened. In the assembly of the crane this frame rests on top of the gantry and is used for securing the guides, along which the tower slides during lifting. Upon termination of assembly the frame is disconnected from the gantry, lifted with screw jacks to 200 mm and attached to the tower.

The gantry of the crane is a three-dimensional design, designed on a 3 point support. We see installations for elevating the tower during assembly of the crane

in the gantry.

In the development of the plan of the crane the possibility was given to construct its supporting constructions according to a diagram applicable in contemporary mobile cranes (BK-215, MSKZ-5/20 and others). On the basis of this diagram the counterweight is located on the level of the support-rotary installation and the arm is retained by a vertical pulley block due to the fact that the tower almost does not receive any buckling.

In the BK-1425 crane the counterweight and vertical pulley block could be placed at a distance not more than 6 m from the axis of rotation; the weight of the counterweight and stress in the pulley block (vertical) must be equal to approximately 300 tons, which could lead to a significant complication in design and realization of its loading. For the basic lifting a loading pulley block is used which can operate with ten and four fibers with corresponding changes in lifting power and speed. Shifting of the pulley block from one circuit to another is done without overpassing the cable, as this is seen from fig. 4. The pulley block serves as a multi-speed winch with a lifting power of 2 x 9 tons, the kinematic diagram of which is given in fig. 5.

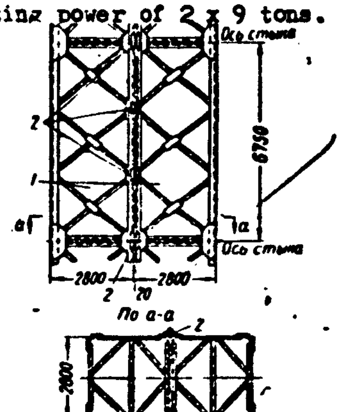

Figure 2.

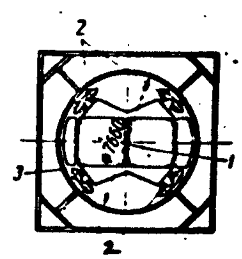

Figure 3.

Fig. 2. Construction of Crane Tower. 1-sections; 2-joining angles

Fig. 3. Horizontal supporting rollers of the tower.
1--tower; 2--supporting rollers; 3--supporting ring of gantry.

The winch has two electric motors with a power of about 45 kw each. The shafts of the electric motors are connected by means of gear connections with shafts of

nonsymmetrical differential introduced into the make-up of the decceleretor. On the output rollers of the decceleretor two drums are attached, on which both ends of the cable of the lifting pulley block are wound. On both gear connections of the second electric motor the average speed of winding the cables on the drum and the braking is equal to 36 m/min. in this case. In turning on the second electric motor to this speed it is boosted or cut down depending on the direction of the rotation of the shaft of the electric motor, to 28 m/min., as a result of which the total speed of the cables is equal to 64 or 8 m/min. Similar speeds are also obtained in lowering the load. In the winch a constant rigid connection is maintained between the shafts of the electric motors and the drum shafts. The winch for lifting an additional load is similarily constructed.

SEE PAGE 7a FOR FIGURE 4.

Fig. 4. Diagrams of basic lifting pulley blocks.
a--pulley block with ten fibers; b--pulley block with four fibers; c--shifting the pulley block with ten fibers to four fibers; 1--two-roll block; 2--three-roll block; 3--immobile block on end of arm; 4--connecting axis; 5--fixation axis.

Elevation of the arm is done by a winch with a lifting power of 9 tons, and

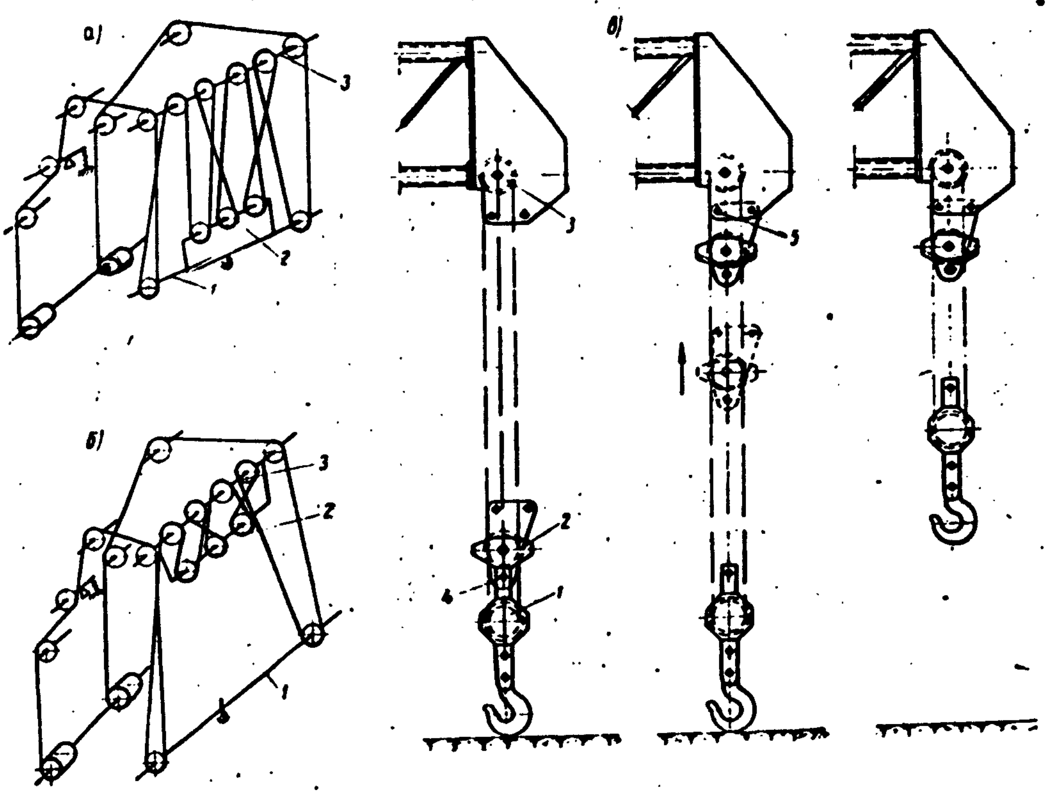

Figure 4.

turning of the tower by a winch with a tractive force of 18 tons. All winches and elevation electrical apparatus are placed in the machine section, located on the frame attached to the tower (see fig. 1). Here we find the machinist's cabin. Such a position significantly improves the conditions of observation of the load and all mechanisms.

The movement mechanism of the crane consists of four two-rail drive trolleys (fig. 6). In connection with a large load, reaching up to 288 tons on one trolley, there are eight wheels in each of them.

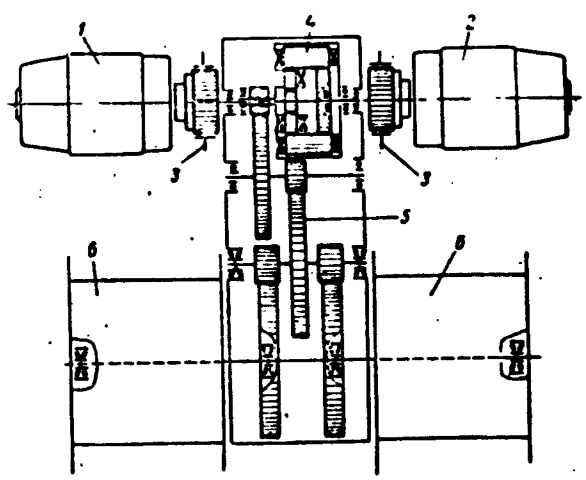

Fig. 5. Kinematic diagram of a multi-speed winch of basic lifting.
1--first electric motor; 2--second electric motor; 3--brakes; 4--differential; 5--deccelerator; 6--drum.

Support of the braces of the gantry on the balancing rollers of the trolley, and the rollers on the frames, in which the wheels are attached, is done by means of

spherical bearings. This provides the possibility for the trolleys to be revolved around a vertical axis, due to which the crane can be converted along a curved route of a comparitively small radius. In the plan we see the possibility of installing the crane on a monorail trolley, which can turn out to be necessary in operation of the crane on a scaffold bridge.

On the BK-1425 crane there are two lifting power limiters, one of them connected with the blocks of the arm pulley block and it restricts the lifting power in the limits of a curved part of the graph, the other is connected with blocks of the loading pulley block and restricts the maximum lifting power.

In the machinist's cabin there is a receiving-transmitting radio set. The chief of the assembly crew working with the crane has such a portable set.

Assembly of the BK-1425 crane is done by the method of raising, the most effective for cranes of this type.

According to technical indices the BK-1425 crane has an advantage before other types of heavy tower cranes. Thus, for example, the weight of the construction on one tm payload consists of 0.275 t/tm is the BK-1425 crane, and in the BK-406A crane, having a smaller lifting height, this weight is equal to 0.3 t/tm (without allowance for 50-ton ballast).

From reports of the foreign press we know that in Australia in 1957 in the construction of a blast furnace a specially planned stationary tower crane was used, which had a maximum lifting power of 60 tons on a boom up to 18.25 m and 15 tons at a maximum boom of 35.12 m. The crane has an additional lift of 12 tons on the end of the arm with a maximum boom of 37 m. The load moment of the crane is 1,100 tm (fig. 7).

The Australian crane has a less perfected design and worse technical indices than the BK-1425 crane which is seen from the data in the table.

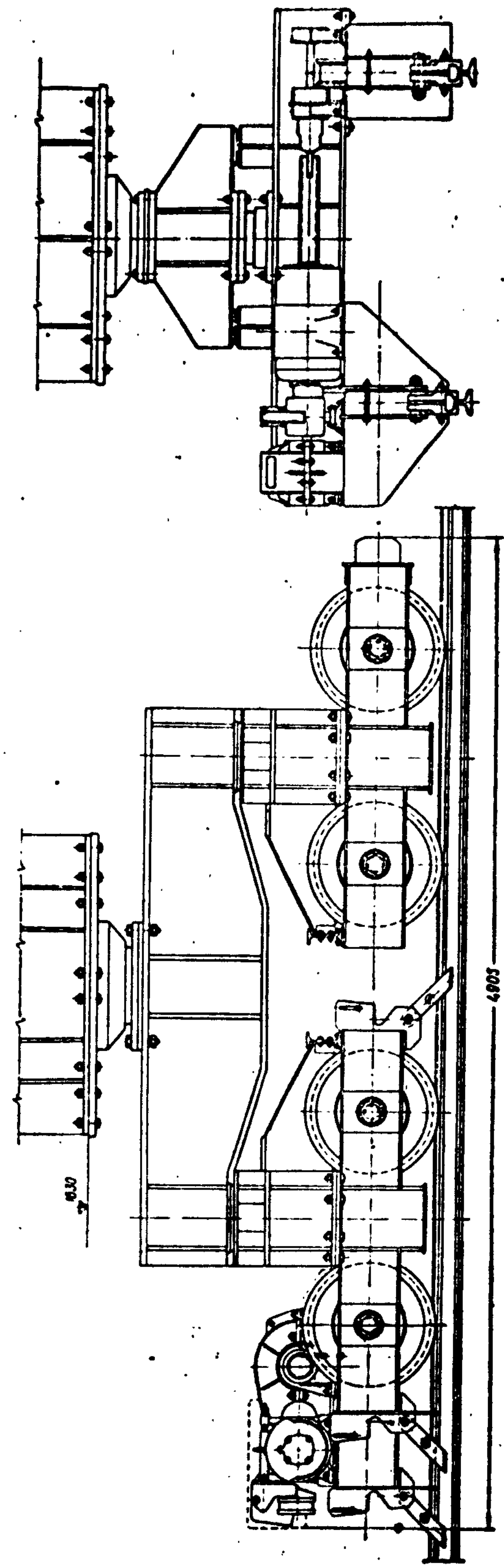

Fig. 6. Running trolley.

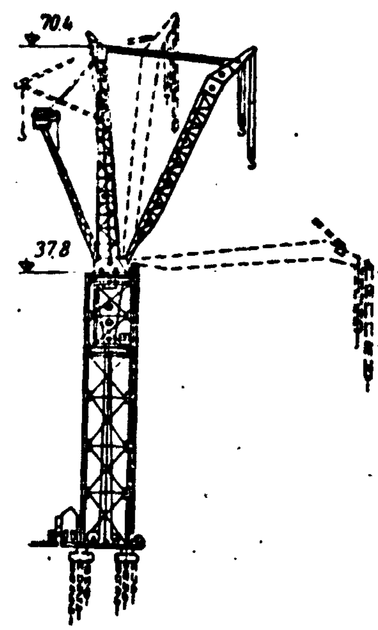

Fig. 7. Tower crane, used in construction of blast furnace in Newcastle.

Characteristic	BK-1425 Crane	Australian Crane
Maximum lifting power in m	75	60
Boom in maximum lifting power in m	19	18
Maximum boom in m ...	50	45
Lifting power in maximum boom in m	20	15
Arm joint mark in m .	55	38
Maximum lifting height in m	98	65
Total weight (without motion mechanism, absent in Australian crane) in m ..	357	300

Characteristic	BK-1425 Crane	Australian Crane
Weight per 1 tm of payload (without motion mechanism) in t/tm	0.251	0.278

The application of powerful tower cranes of large lifting capacity requires clear organization of assembly operations, since only in this case can the effective utilization of cranes be secured by high productivity and loading, corresponding to a relatively high cost of machinery replacement.

In the construction of blast furnaces with a volume above 1,719 m^3 the BK-1425 crane (tower) must be the basic mechanism, assembling all attached parts of the central site: especially a blast furnace, air heaters, foundry yards, dust catchers and inclined gas lines.

The weight of the basic assemnly parts must be brought up to 25 to 70 tons. For assembly of parts of smaller weight: the construction building of air heaters, working areas and others, additional mechanisms must be used (caterpillar cranes SKG-50 and SKG-30/10, and also the BK-300 crane). The diagram of arrangement of the assembly mechanisms shown in fig. 8 provides for their most effective utilization. According to this diagram the BK-1425 crane is assembled in position 1 and in completion of all operations of the "zero" cycle, consequently, all heavy, attached parts of the blast furnace, air heaters, foundry yard, dust catchers and gas lines the crane installs from stands 2--3--4. The successive operations in assembling parts of small weight are accomplished by the SKG-50 and SKG-30/10 caterpillar cranes.

Consolidation of assembled parts of the blast furnace complex during brief periods of construction must be done with specially made mechanisms (caterpillar, railroad or gantry cranes).

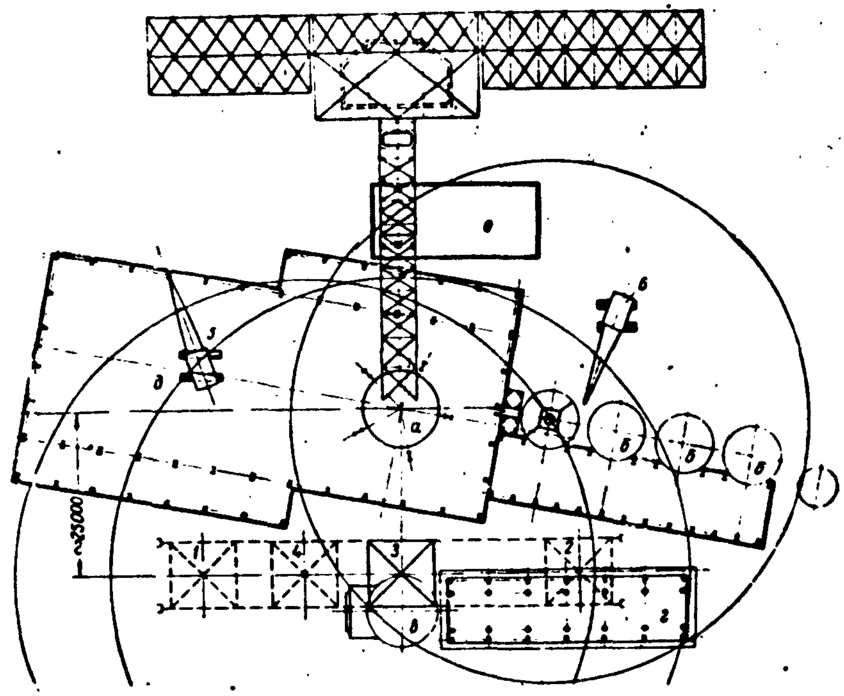

Fig. 8. Arrangement of basic mechanisms in construction of a blast furnace with a volume of 2,200 m^3.

a--blast furnace; b--air heaters; c--dust catchers; d--casting yard; e--machine shop: 1, 2, 3, 4--stands of BK-1425 crane (tower): 5, 6--SKG-30/10 and SKG-50 caterpillar cranes.

In constructive decisions, adopted in typical plans of blast furnaces with a volume of 1,386, 1,513 and 1,719 m^3, the assembly parts are insufficiently consolidated. So, for example, for a blast furnace with a volume of 1,719 m^3 only 7% of the total number of liftings pertain to parts weighing from 15 to 50 tons; the weight of such parts consists of about 30% of the total number of all parts.

A large quantity of small parts of constructions assembled after installation of the consolidated connections lengthen the periods of assembly, do not offer the possibility of seriously reaching labor productivity and effectively using cranes

of large lifting power.

At the present time in planning blast furnaces having a volume of 2,000 m^3 and more the planning institutes of Gipromez (State Institute for the Design and Planning of Metallurgical Plants), Proyektstal'konstruktsiya (State Institute for the Design, Study and Testing of Fabricated Steel and Bridges) and Promstal'konstruktsiya (Design and Planning Office of the Main Administration for the Building and Installation of Fabricated Steel Structures) are collectively developing constructive solutions, which should secure a decrease in the quantity of assembly parts and an increase in the number of blocks which may be consolidated before installation. In this case, the BK-1425 crane will be effectively used in the installation of parts of the housings of furnaces and air heaters, construction of pile drivers and charging platforms, circular piping, candles and gas drain lines with guard plates and linings weighing up to 50 to 70 tons, and also consolidated into panels of mine shafts with areas along the entire perimeter. The realization of these measures, and also the individual fulfillment of "zero" cycle building operations, permitting full utilization for consolidation assembly and maneuvering of auxillary mechanisms of the immediate blast furnace areas, will create better conditions for fulfilling all building and assembly operations according to a single graph and secure further curtailment of construction periods and an increase in labor productivity.

The BK-1425 crane should find broad application in the construction of thermoelectric power plants and replace the BK-405 cranes with a lifting power of 40 tons which are presently being used. The BK-1425 crane is more universal and maneuverable than the various gantry and semi-gantry cranes which rest on preliminarily installed constructions of the framework of a building.

Application of BK-1425 cranes is also noted in the construction of new hydroelectric plants, in particular the Saratov Hydroelectric Plant, at which heavyweight assembly reinforced concrete constructions will be used for the dam and

and plant building.

In many areas of construction, where the application of assembly parts and blocks of large weight are stipulated by technical and economic considerations, the use of tower cranes with a lifting power of 75 tons will permit the successful solution of problems of increasing the industrialization level and curtailment of the periods of labor production.

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